UTILIZATION OF WASTE

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TINTED GLAZES CONTAINING FLOAT WASTE

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An opacified tinted glaze for facing tiles has been obtained on the basis of float-waste from a copper-concentrating factory. The optimum glaze compositions with good physiochemical properties are identified.

Interest in opacified glazes is due to the prospect of developing new glaze coatings with improved physicochemical properties and the possibility of replacing opacifiers (titanium, zircon, etc.) by more available and inexpensive materials. It was earlier proposed [1, 2] to use float-waste generated at copper- and fluorite-concentrating factories for glass production and subsequent production of glass-ceramic facing materials.

Considering previous studies and available published data, our aim was to develop new compositions for tinted opacified glazes produced in low-temperature firing, which differ from existent glazes [3, 4] in their compositions and opacifying phase, which was represented by silica-bearing float-waste from a copper-concentrating factory.

The basic composition was a glaze [5] containing 20 – 40% (here and elsewhere in wt.%) float-waste from the copper-concentrating factory. The effect of this waste on the physicochemical properties of frits and glaze coatings, as well as recrystallization processes, were investigated.

The initial materials for preparing glaze batches were float-waste, feldspar, borax, dolomite, and zinc oxide.

The float-waste from the copper-concentration factory at the Almalykskii Mining-Metallurgical Works has a dark gray color, is generated in concentration of the copper-bearing ore, and constitutes an aluminoferrous silicate compound. It is established that the chemical composition of waste samples taken in different seasons is virtually identical. The waste samples have a relatively high content of SiO_2 (up to 62.92%). The float-waste has a finely dispersed granulometric composition.

The chemical composition of the float-waste samples is (%): 61.20 – 62.92 SiO_2, 11.89 – 13.11 Al_2O_3, 1.00 – 1.96 CaO, 5.70 – 9.17 Fe_2O_3, 1.58 – 2.81 MgO, 0.81 – 1.56 Na_2O, 4.54 – 5.80 K_2O, 3.68 – 5.93 SO_3, and 3.94 – 4.54 calcination loss.

The granulometric composition of float-waste samples is as follows: content of 0.50 mm fraction — 0.75 – 1.05%, 0.30 mm — 3.10 – 3.50%, 0.20 mm — 1.15 – 1.55%, 0.10 mm — 1.80 – 2.40%, 0.025 mm — 17.65 – 18.35%, 0.006 mm — 70.95 – 72.40%. The melting point of the float-waste is 1220 – 1230°C.

The main mineral components of the waste considered are quartz (up to 44%), feldspar (up to 9%), hydromica (up to 22%), and also about 3% gypsum, calcium carbonate, and magnesium carbonate.

It should be noted that introducing up to 30% waste into a glaze composition significantly lowers the melting point of frit (1250°C). A further increase in waste content impairs the melting capacity of glass melt and raises its melting point.

Table 1 lists the chemical composition of glazes considered containing float-waste.

It was established in frit melting that upon introducing 20 – 40% waste into the glaze composition no liquation phenomena were observed. Sharply cooled and granulated in water, supercooled melt represented clear homogeneous dark brown glass.

The glaze suspension was prepared as follows: frit was milled by wet milling with 0.05% soda ash and 0.2% sodium silicate solution in a ball mill (moisture 40 – 42%). The milling dispersion was characterized by a 0.01 – 0.02% residue on a No. 0056 sieve, the glaze density was 1.56 – 1.58 g/cm^3.

The glaze suspension was applied by immersion to ceramic tiles (mosaics) produced by the Tashkent Experimental Applied Arts Works. After glazing, the products were dried and fired according to a preset schedule in an electric furnace at a maximum temperature of 900 – 950°C with an exposure for 1 h.

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TABLE 1

Glaze	Mass content, % SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	B_2O_3	ZnO
Basic G*	56.38	9.66	0.74	6.55	1.14	5.58	3.67	8.28	6.76
G-1	52.31	12.76	0.82	5.37	2.78	6.17	5.12	7.69	6.98
G-2	53.17	12.87	0.97	4.94	2.39	5.97	5.16	7.65	6.93
G-3	51.01	12.03	1.11	6.00	2.99	6.14	5.00	8.70	7.10
G-4	51.85	12.08	1.25	5.57	2.57	6.05	4.94	8.63	7.06
G-5	50.72	11.54	1.41	6.62	3.16	5.87	4.77	8.75	7.16

* In addition, basic glaze contained 1.19% CaF_2.

TABLE 2

Glaze	Fusibility, °C t_1	t_2	t_3	t_4	Softening temperature, °C	TCLE, 10^{-7} K^{-1} calculated by Appen method	TCLE experimental at temperature 400°C	TCLE experimental at softening temperature	Luster, %	Viscosity at 650°C, Pa · sec	Microhardness, 10^{-4} kg/m^3	Density, kg/m^3	Elasticity, kg/m^2	Chemical resistance of crystallized frits, % in 2 N NaOH	in 20% HCl
G-1	910	930	950	970	660	59.8	61.2	65.3	38	18.4	5.8	2900	8.5	99.92	99.98
G-2	880	900	930	950	600	58.4	60.6	64.8	42	17.3	5.9	2884	7.8	99.90	99.97
G-3	880	920	940	960	580	56.6	59.2	63.5	54	16.5	6.0	2798	7.7	99.87	99.99
G-4	860	880	900	930	560	55.4	58.5	61.7	52	15.8	6.2	2726	7.6	99.84	99.97
G-5	780	800	820	880	550	54.7	57.7	62.9	44	14.2	6.4	2754	7.6	99.80	99.96

The glazes obtained have smooth velvety surface of a mustard color and high luster parameters. The physicochemical properties of opacified glazes containing float-waste are given in Table 2.

The glazed samples are heat-resistant (GOST 13449–82). It was found that with increasing waste content the chemical resistance of frits crystallized at 920 – 950°C is 99.92 – 99.98%. The microhardness of samples glazed and fired at 900°C gradually increases with an increasing waste content.

The Tashkent Experimental Arts Works carried out industrial testing of ceramic tiles coated by the tinted opacified mustard-color glaze and got positive results.

Thus, the use of float-waste of the copper-concentrating factory makes it possible to obtain inexpensive opacified colored glaze of mustard color with a lustrous furnace. This not only decreases the batch production cost but also contributes to solving the environmental-protection problems.

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